NET-ZERO INDUSTRIES
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Project Title	Carbon2Business
Industry Partner	Holcim GmbH Germany
Industry Sector	Cement & Lime
Technology Pathway (Primary)	Alternative Materials and More Efficient Processes
NIM Pillar	Technology Demonstration
Source	NIM Awards 2023
Description	The Carbon2Business (C2B) project aims to be the first carbon neutral/net-zero cement plant of the world at Holcim Germany's facility in Laegerdorf, Germany by 2029. Holcim will build a new kiln line, using an innovative 2nd generation oxyfuel process and a downstream Compression and Purification Unit (CPU). It is a first-of-its kind carbon capture technology which is funded with 109.8 million euros by the EU Innovation Fund in 2022. We will provide the captured CO2 as a raw material to different industries in the region (Carbon Capture and Utilization Project). Technical Concept: Combustion air is substituted with pure oxygen (from the Electrolysis) resulting in a CO2-rich flue gas, which is then cooled down, purified and liquified in a CPU. The flue gas is then further processed into a high-purity CO2 gas as a raw material for other industries. Holcim is cooperating with thyssenkrupp Polysius and Linde Engineering as technology partners for the project. The C2B project is part of the Power to X supply Chain project HySCALE/ Westküste 100. We will capture more than 1 million tons of CO2 emissions annually and further process it in a methanol synthesis to produce E-Fuels and plastics or pass it on as a raw material to other industries. With this Carbon Capture and Utilization (CCU) project, we are creating new value chains and developing technologies to enable the decarbonization of industrial companies beyond the cement industry.
Innovations Employed	Forming this first-of-its-kind Carbon Capture and Utilization (CCU) project has the potential to transform value chains of energy-intensive industries such as cement, steel and chemicals to a green circular economy environment. The Carbon2Business project delivers innovation in three categories: by 1) driving the development of low carbon technologies, 2) taking a cross value chain approach and novel CO2 use case and 3) yielding renewable based products for the low carbon economy. The first-of-a-kind commercialization of C2B mainly consists in changing the conventional clinker production process in Laegerdorf from 'air-mode-fired' to 'oxygen-mode-fired', and thus increasing the CO2 concentration to a technically reachable maximum. Moreover, the power demand will be covered by renewable energy from own windfarm and green PPE. By installing an innovative 2nd generation oxyfuel process and subsequent CPU, Carbon2Business aims for a technical solution which is sufficiently mature (TRL 6), however not yet commercially available, although the oxyfuel concept has been previously proven at pilot plants.

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	The degree of innovation of C2B is breakthrough as the implementation of the 2nd generation oxyfuel process + CPU presents a completely new full-scale process in the cement sector.
Dimension of Novelty	**Company & Country** It was new to Company and Country First green CO2 value chain project (CCU) in Germany in a circular economy environment
Innovation Collaboration	**In-house** Project Team (Germany) and with our global Research & Development department (Swiss) **Cooperation with scientific institutions** Verein Deutscher Zementwerke (VDZ) **External Partners** Thyssen Krupp Polysius (TKP) and Linde GmbH, Linde Engineering Dresden (LEDD)
Intellectual Properties	Holcim will not obtain intellectual property rights for the infrastructure elements to be installed at Laegerdorf. Thyssen Krupp Polysius (TKP) owns at least two patents for the oxyfuel technology of the second generation, which is envisaged to be installed at Laegerdorf: WO 2019211196 and WO 2019211202. Linde GmbH, Linde Engineering Dresden (LEDD) owns the patent EP 2365866 B1(Method for removing impurities from gas flows comprising oxygen), which will be applied in the CPU.
IP Links	**TKP** PATENT – WO2019211196-A1 PATENT – WO2019211196 PATENT – WO2019211202-A1 PATENT – WO2019211202 **Linde GmbH** PATENT – EP2365866 PATEN T- PL-2365866-T3
Timetable & Progress	**Prototype system tested in intended environment and operating at close to expected performance (TRL 6)** TRL Before Requested Support: TRL 6 - technology demonstrated in relevant environment IRR Before Requested Support (%) 4.48. The C2B project started by successfully applying with industrial partners in the region for German R&D funding which is called 'Reallabore der Energiewende'. Within the 'Westküste100' consortium we started to investigate the interaction between the different industries and develop green circular economies (in 2019). Here C2B project was born.

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Financing (Public/ Private)	**Funding Public** Reallabore der Energiewende (Westküste100), EU Innovation Fund.
Finance Links	EU Innovation Fund
Project Phase TRL	TRL 6
Problems to be Solved and Risks to be Managed	Risk analyses at the component level were performed by TKP for the oxyfuel technology and by LEDD respectively for the CPU. In addition, Holcim performed a risk assessment focusing on site-specific risks. The risks regarding the contractual agreement on the oxygen supply as the CO2 use have been addressed on technical and operational level. Moreover, the set-up of a completely new transport and logistic infrastructure for CO2 in Germany is difficult as the political framework conditions are not available yet. Here, Holcim is in close dialogue with Authorities and political stakeholders. Additionally, C2B aims at producing "green cement", which is a new market and supports the development towards sustainable construction in the cement industry. Overall, Carbon2Business presents a manageable risk due to the fact that the technological solutions have been demonstrated in prior applications (or will be further developed in parallel) resulting in a TRL 6 for the oxyfuel concept at the time of the final investment decision of Carbon2Business. Based on the subsystems TRL, it will be feasible to take the 2nd generation oxyfuel process to a TRL of 8 in an industrial application at low risk. Subsystems with TRL of less than 6 be executed with a higher process reserves and/or is designed for a fallback scenario/position.
Preliminary or Final Results Achieved	Approximately 1.2 million tons of CO2 will be saved after successfully executed the C2B project which is 7% of state emissions. We will also help to decarbonize the building industry while producing an extensive amount of green cement (4,500 t/day) for northern Germany. Within C2B, substantial technological (see below) as well as economical barriers (e.g., de-risking, enabling of cost reduction for future projects) will be overcome. By installing an innovative 2nd generation oxyfuel process and subsequent CPU, Carbon2Business aims for a technical solution which is sufficiently mature (TRL 6), however not yet commercially available, although the oxyfuel concept will be previously proven at a pilot plant before starting execution. The degree of innovation of C2B is breakthrough and we will reach TRL 8 which will open the door for other cement plants in the world applying the technology. The establishment of forming a novel CO2 use case has also the potential to transform value chains of energy-intensive industries such as cement, steel and chemicals. We build up a complete new supply chain for the use of CO2 within HyScale100, bringing the real-laboratory Westküste100 to an industrial scale. Moreover, C2B will build up the first CO2 infrastructure at a deep sea harbor in Germany with a CO2 pipeline and a CO2 Hub. This transformation of the Westcoast of Germany has the potential to be a role model for other regions in Europe and the World. Carbon2Business delivers innovation in three categories: by 1. driving the development of low carbon technologies

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	2 taking a cross value chain approach and novel CO2 use case 3. yielding renewable based products for the low carbon economy.
CO2 Emissions Reduction Potential - Implementation and Future Market	Accounting for about 7% of European CO2 emissions, the cement industry will play a central role in going towards a low carbon economy in Europe. Currently, the European cement industry is emitting a total of over 120 million tons of CO2 per year, 20.5 million of which fall on cement production in Germany. Holcim Ltd as a leading global building materials company is one of the first companies in the world to have its short- and long term CO2 targets (until 2030 and 2050) validated by the Science Based Targets initiative for all scopes and for setting reference for the entire industry. The technology roadmap for the low-carbon transition in the cement industry by the International Energy Agency (IEA) and the Cement Sustainability Initiative (CSI) (2018), shows that innovative technologies, including carbon capture, account for 48% of the total CO2 emission reduction potential in the sector. By carbon capture in combination with biogenic fuels a "CO2 negativity" is planned. Despite the acknowledged role that carbon capture technologies will have to play in tackling climate change and although the technologies are in principle available, they have not yet fully reached the commercialization stage due to the inherent technological risk that comes with the large-scale demonstration as well as a lack in cost-effectiveness and market incentives. Thus, the cement industry is in need of first movers in order to enable early adopters of innovative low-carbon technologies in the sector leveraging the decarbonization potential and scaling effects improving cost efficiency. HOL is determined to become a frontrunner by implementing a first-of-its-kind 2nd generation oxyfuel process and CO2 use case in Laegerdorf. Projected captured CO2: about 1.2 million tons CO2 / per year.
Market Positioning	Company stated they have several customer inquiries for “green cement”. A prominent example is Hamburger Hochbahn AG with its "U 5" project in Hamburg (underground line).
Project Location	Germany
Project & Technology Links	Holcim Success Story Leaflet CCUS, Laegerdorf Carbon2Business, PDF, project chart Westküste100-Green-Hydrogen, PDF, Chart, Westküste100 20230215_C2B_Animation_englisch.mp4.crdownload, CRDOWNLOAD, Carbon2Business Laegerdorf, Project Video Video: CLICK HERE
Technology Links	**Holcim** Carbon2Business Project Video: CLICK HERE **Westküste100-Green-Hydrogen** Green Hydrogen Westkuste100